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THE PETROGRAPHICAL PROVINCE OF ESSEX COUNTY, MASS. III

ROCKS OCCURRING IN DIKES

THE rocks described in the preceding part of this article are cut by numerous dikes of various kinds, ranging from very acid aplites to basic diabases. The last are, as is usual along the Atlantic border, the most numerous; aplites and acid granite-porphyries come next, and finally there is a smaller number of rare and interesting types of alkali-rich dike rocks. These have not yet been fully investigated, but, as the rather large number of specimens in my possession represent apparently the main types, a description of them will give at least an approximate idea of the intrusive rocks of Essex county.

GRANITIC DIKES

Aplite.—Dikes of this rock are confined almost exclusively to the granite areas, at least as far as my observations permit me to judge. They are usually very narrow, only a few inches in thickness, and contact phenomena are not very conspicuous.

Megascopically they are dense and fine-grained, of various shades of light gray, and often showing a few small biotites. In thin section they show no very remarkable peculiarities, being a holocrystalline mass of small anhedra of quartz and alkali-feldspar, the latter usually microperthitic. Micrographic inter-

growths of feldspar and quartz are rather common. Colored components are rare, those most often met with being olive-green hornblende and brown biotite, while colorless diopside is less frequent. A few specimens carry titanite and magnetite, while apatite is seldom seen. These aplites are occasionally coarser-grained, and become microgranites, when they resemble closely the granites proper, except that the crystallization is on a smaller scale, and colored minerals are rare.

The most interesting aplitic dike found is one cutting a granite exposure near Bass Rocks, Gloucester. It is the same mass as that mentioned previously with enclosures of orbicular syenite and diorite, and the aplite cuts granite and enclosures impartially. The dike is only 6–7 cm wide, and is notable on account of being compound in an anomalous way. The borders, about 2 cm on each side, are of fine-grained white microgranite speckled with small, black biotite and hornblende flakes. This shows under the microscope the usual microgranitic structure and characters. Extending down the center is a band, about 2 cm in width, of a dense, almost aphanitic light gray aplite, which shows under a lens only very minute black specks. This in thin section is a very finely granular aggregate of round quartz and alkali-feldspar anhedra, with here and there small shreds of green hornblende and pale brown biotite.

The junction between the two facies of the rock in the hand specimen is slightly irregular but sharp. Under the microscope it is also seen to be fairly sharp, but the quartzes and feldspars of the borders show a tendency to granularity and passage into the aplite which is suggestive of crystallization out of one magma and not that due to two injections. This idea of differing crystallization in one magma is also supported by the uniformity with which the aplitic band sustains its central symmetrical position with reference to the two sides. The highly anomalous character of the dike will have been noticed, in that the borders, contrary to the usual rule, are more coarsely crystalline than the central portion. If we adopt Judd's[1] view of the composite dikes

[1] J. W. JUDD, Q. J. Geol. Soc., Vol. XLIX, p. 536, 1893.

of Arran it is easy to explain this by assuming that the first-formed dike cracked down its center, and that this crack was filled by a later injection, which, cooling rapidly, solidified as aplite. This is not the place to enter into a discussion of the subject, but it may be said that in view of the facts noted above, the similarity in chemical composition of the two portions, and for other reasons, this explanation does not seem to be the correct one, and we are forced to conclude that the dike is due to only one injection. In this case the coarser crystallization at the borders may be due, as Professor Iddings has suggested to me, to the presence of mineralizers derived from the surrounding granite, or, as seems to me more probable, to certain peculiar physical and chemical conditions which I hope to explain in another place.

	I	II	III	IV
SiO_2	77.49	76.44	77.14	77.61
TiO_2	0.25	0.37	0.29	0.25
Al_2O_3	11.89	12.95	12.24	11.94
Fe_2O_3	0.34	0.19	0.29	0.55
FeO	1.12	0.89	1.04	0.87
MnO	trace	trace	trace	trace
MgO	0.09	trace	0.06	trace
CaO	0.45	0.15	0.35	0.31
Na_2O	4.58	4.76	4.64	3.80
K_2O	4.26	4.95	4.47	4.98
H_2O (110°)	....	....	....	trace
H_2O (ignit.)	0.16	0.09	0.14	0.23
	100.63	100.79	100.66	100.54

I. Aplite. Border of Dike. Bass Rocks. H. S. Washington anal.
II. Aplite. Center of Dike. Bass Rocks. H. S. Washington anal.
III. Aplite. Composition of whole dike, two parts of I, one part of II.
IV. Granite. Rockport. H. S. Washington anal. JOUR. GEOL., VI, p. 793, 1898.

Analyses were made both of the border and of the center and are given above in I and II. The composition of the dike as a whole, calculated from two parts of I and one part of II, is given in III. The two parts of the dike are seen to be sensibly identical in composition, the border with a little more silica, lime and magnesia, and a little less alumina and alkalies. The

composition of the dike as a whole is remarkably similar to that of the granite of the region (analysis IV), the only noteworthy difference being in the soda.

Quartz-syenite-porphyry.— Dikes of this are met with in considerable numbers in the granite areas, especially that of Cape Ann, where they have been mapped by Shaler.[1] The best specimens in my possession come from the dikes numbered by Shaler 52, 53, and 70 on Eastern Point, and 245, a short distance north of Squam Light, the last being the freshest. Megascopically they show phenocrysts of alkali-feldspar, hornblende and biotite, and fewer of quartz; scattered through a fine-grained groundmass composed of feldspar, some quartz and specks of ferromagnesian minerals. The specimen from near Squam Light is a rather dark ash-gray, while the others are brownish-gray.

Under the microscope the large feldspars are seen to be microperthitic and are all cloudy and somewhat decomposed. The large hornblendes are ragged in outline and usually slightly altered, brown limonitic flakes being seen at their edges. They are of a peculiar, rather vivid grass-green, resembling that of actinolite, and are quite pleochroic. A few ragged plates of greenish-brown biotite are seen as phenocrysts. The groundmass is granitic and holocrystalline, the quartzes clear and generally interstitial between the feldspars. These are almost entirely of orthoclase or soda-orthoclase, not usually microperthitic, with a few doubtful oligoclases. They show a marked tendency to automorphic development. Irregular shreds of hornblende and biotite, similar to those forming the phenocrysts, are quite common, the former being the more abundant. A few small grains of magnetite and titanite are seen here and there and minute needles of apatite are fairly common.

For analysis the freshest specimen from Dike 245, north of Squam Light, was chosen, the result being given below, with that of the Wolf Hill nordmarkite for comparison.

[1] SHALER, Ninth Ann. Rep. U. S. Geol. Surv. Plate LXXVII.

	I	II	III
SiO_2	68.88	68.36	69.00
TiO_2	trace	trace	0.35
Al_2O_3	14.96	16.58	13.95
Fe_2O_3	0.64	0.90	1.56
FeO	4.64	3.24	2.38
MnO	trace	trace	0.55
MgO	0.37	0.45	0.14
CaO	1.74	1.85	0.49
Na_2O	3.83	3.97	5.67
K_2O	4.97	5.27	5.11
H_2O (110°)	0.06	0.18	....
H_2O (ignit.)	0.24	0.17	0.70
	100.33	100.97	99.95

I. Quartz-Syenite-Porphyry. Squam Light. H. S. Washington anal.

II. Nordmarkite. Wolf Hill, Gloucester. H. S. Washington anal. JOUR GEOL., VI. p. 800, 1898.

III. Lindoite. Frön, Norway. V. Schmelck anal. Brögger: Eruptivgest. des Krist. geb. I, p. 139, 1894.

The composition is rather acid, with high alkalies and rather high lime, with ferrous oxide largely in excess over ferric, and is closely similar to that of the nordmarkite. These dikes resemble in certain ways the lindoites of Brögger, which are acid bostonitic rocks. This is seen from the chemical point of view by comparison of I and III, that of the Essex county rock differing materially only in the slightly higher lime. Mineralogically they also resemble each other closely, though blue arfvedsonite or riebeckite is common in the lindoites, while the hornblende here is a peculiar green with only a tinge of blue. One specimen of lindoite in my possession from Huk in the Christiania Fjord, collected under the guidance of Professor Brögger, shows greenish-brown hornblende with some biotite, and does not differ radically from the present dike rocks. Structurally also the two resemble each other, the groundmass feldspars being quite automorphic in stout tables, the quartz interstitial and the hornblende irregular.[1] We do not, however, find in our rocks the zircon which is so common in the Norway

[1] Cf. BRÖGGER, *op. cit.*, I, Fig. 15, p. 137.

rocks. These dike rocks might then with propriety be called lindoite, but in view of their more porphyritic character and for other reasons they will be referred to as quartz-syenite-porphyry.

In this connection must be described two rocks found cutting the gabbro at Nahant. The one, which occurs at Little Nahant, is fine-grained, scarcely porphyritic, mottled gray, pink and green, and is evidently considerably altered. It is essentially a hornblende-biotite-quartz-syenite, and resembles in most particulars the rocks just described. The feldspar is apparently mostly orthoclase, and the hornblende is of a similar peculiar green, not highly pleochroic, and much of it seems to be secondary. The biotite, which is primary and which occurs in smaller amount, is the most notable feature. It occurs as stout crystals with ragged edges, often partially altered to the green hornblende. Its color is greenish-brown, and the strong pleochroism is very striking and unusual; parallel to the cleavage deep grass-green, perpendicular to this reddish yellow-brown, the absorption in the former direction being much the stronger.

The second rock, which is found at the road-metal quarry at Nahant as narrow dikes and small "schlieren" in the gabbro, is a compact, almost aphanitic, rather dark gray rock without phenocrysts. In thin section it shows a multitude of small isodiametric crystals of biotite having a peculiar light yellowish color and usual absorption scheme. With these are very many small colorless diopside anhedra, which in parts of the slide become more numerous. These, together with many magnetite grains and some small apatite needles, are embedded in a colorless or slightly yellow mass, which between crossed nicols is seen to be composed of tabular orthoclase crystals with fewer of a twinned oligoclase, the mesostasis being in patches either alkali-feldspar or quartz, the latter less abundant. In places the feldspar mesostasis extinguishes simultaneously over large areas and becomes poikilitic in character, and in these areas automorphic feldspar crystals are wanting. The tabular feldspars are in fact best developed and sharpest when surrounded by interstitial quartz, when in feldspar they are much less well

defined and more uncertain in outline. The structure as a whole is a rather peculiar one. The rock would seem to be not very acid and with rather high potash, and its occurrence in connection with the gabbro (which it will be remembered also carries some orthoclase) is noteworthy.

A rock which is essentially an *alkali-syenite-porphyry* occurs as a dike on the southeast coast of Marblehead Neck cutting the rhyolite. It somewhat resembles a minette, though rather more acid. Hornblende is absent, diopside rare, and small stout crystals of biotite abundant. These are usually a peculiar light brown and pleochroic, but some are seen of a pale green, slightly bluish in tone, and with feeble pleochroism. This variety also occurs intergrown with the brown, and may be a bleached form of the latter, but it resembles closely the similarly colored biotite found in some of the granites, especially that of Marblehead Neck itself. The groundmass of alkali-feldspar is granular, much of it being decomposed with formation of kaolin. A few grains of probably secondary quartz are present.

PAISANITE-SÖLVSBERGITE-TINGUAITE SERIES

A small but very interesting group of dike rocks is distinguished mineralogically by the combination of alkali-feldspar and either glaucophane-riebeckite or aegirite. These carry abundant quartz at the acid end of the series (paisanite), little or no quartz in the intermediate members (sölvsbergite), and nepheline in the most basic (tinguaite). This series, it will be observed, corresponds very closely to Brögger's Grorudite-Sölvsbergite-Tinguaite series from the Christiania region.[1] As far as my observations go, these dikes are not very wide, a few feet at the most. Nearly all my specimens are from dikes cutting granite, either on Cape Ann or along the Manchester-Magnolia shore; one specimen only is from the foyaite area of Salem Harbor.

Paisanite.—The only example of this rock which I found is Shaler's dike No. 3, at the extreme southeast corner of Magnolia

[1] BRÖGGER, *op. cit.*, I.

Point, near the water's edge, which was called by him a quartz-porphyry, and was briefly described by Tarr. It has a width of ten feet, with a strike of N. 2° E. It is cut by a narrow dike of dense black diabase.

The rock is compact, with practically no change in texture throughout its width. Phenocrysts of white or yellowish alkali-feldspar, up to 1.5 cm. in diameter, and smaller smoky bipyramids of quartz are thickly sprinkled through a very fine-grained, rather dark blue-gray groundmass. By the action of the waves and the sea water, with which most of the dike is covered at high tide, the groundmass has been dissolved, and on these surfaces the beautifully sharp and automorphic phenocrysts of feldspar and quartz stand out prominently. The feldspars are stout, prismatic, parallel to the axis *a;* are frequently twinned according to the Carlsbad and also the Manebach laws, and show a number of planes. They will be examined crystallographically later.

Under the microscope the sections present a striking appearance. The sharp quartz phenocrysts are clear, with occasional streaks of minute gas or liquid inclusions, and not infrequently carry rounded inclusions of granular feldspar, or feldspar and glaucophane, like the groundmass; while here and there isolated crystals of glaucophane are also seen. The highly automorphic feldspars are uniformly microperthite, or microcline-microperthite, no plagioclase being seen. They are dusty with minute, often rod-shaped, microlites of a colorless transparent substance, the nature of which is difficult to determine, and are stained, especially at the edges, with limonite. They carry inclusions of glaucophane crystals, or small groundmass patches, which occasionally show a well-developed micrographic structure. There is little evidence of magmatic corrosion, especially in the feldspars, though the quartzes show a tendency to rounded angles and shallow embayments.

The groundmass is very fine-grained, and is composed of minute needles of dark greenish-blue hornblende, up to .01 mm. in length, strewn pellmell in a granular mass of feldspar and quartz. Neither magnetite nor apatite was seen, nor is any

glass present. Along the borders of the phenocrysts, both quartz and feldspar, the hornblende needles are smaller and crowded together, as if pushed aside by the growth of the large crystal, in a manner quite analogous to that described by Pirsson[1] in the case of a tinguaite from the Bearpaw Mountains. There is no evidence of flow structure in the proper sense of the term.

The hornblende is apparently a glaucophane-riebeckite, identical with that described elsewhere[2] in a sölvsbergite from Cape Ann. The extinction angle is small, pleochroism intense; parallel to the axes *c* and *b* dark blue-gray; parallel to axis *a* pale yellow. The position of the axes of elasticity could not be definitely determined, but apparently **c** lies nearest to *c*, indicating that it is a glaucophane.

An analysis of this rock is given below, together with one of the Texas paisanite and one of a grorudite from Norway. The paisanites were discovered by Osann as dikes in Transpecos, Tex., and named after the Paisano Pass, where the types were found. They are composed of quartz, alkali-feldspar, and riebeckite, in the Texas rocks this last forming blue spots in a white groundmass, and quartz and feldspar being also phenocrystic.

	I	II	III
SiO	76.49	73.35	74.35
TiO_2	trace	....	....
Al_2O_3	11.89	14.38	8.73
Fe_2O_3	1.16	1.96	5.84
FeO	1.56	0.34	1.00
MnO	trace	....	0.22
MgO	trace	0.09	0.07
CaO	0.14	0.26	0.45
Na_2O	4.03	4.33	4.51
K_2O	5.00	5.66	3.96
H_2O (110°)	0.12	....	....
H_2O (ignit.)	0.38	....	0.25
	100.57	100.37	99.38

I. Paisanite, Dike 3, Magnolia. H. S. Washington anal.

II. Paisanite, Mosquez Canyon, Transpecos, Texas. A. Osann. Tsch. Min. Pet. Mitth. XV, p. 439. 1895.

III. Grorudite, Varingskollen, Norway. Särnström anal. Brögger, *op. cit.*, I, p. 48, 1894.

[1] PIRSSON, Am. Jour. Sci. (4), II, p. 191, 1896.

[2] H. S. WASHINGTON, Am. Jour. Sci. (4), VI, p. 177, 1898.

The analyses of the two paisanites resemble each other closely, the main differences being in silica, alumina, and ferrous oxide. These rocks are analogous to the grorudites of Brögger, which, however, carry aegirite in place of soda-hornblende, and which are rather less acid than the Magnolia rock. The replacement of alumina by ferric oxide in the grorudite is to be noticed. The phenocrysts differ also in being alkali-feldspar, aegirite, and hornblende, while quartz occurs only in the groundmass, and the color of the rock is dark green, rather than blue, owing to the abundant aegirite.

Sölvsbergite.—The rocks belonging to this group are characterized by the presence of alkali-feldspar with aegirite or a soda-hornblende, with occasional biotite and very little or no quartz. In Norway the structure is generally trachytic, which is not the case in Essex county, but the similarity otherwise, both mineralogically and chemically, is so great that this structural difference may be overlooked.

The Essex county sölvsbergites are fine-grained and compact, not very porphyritic, and of a gray or blue-gray color. As the various dikes show rather diverse characters, they may be described separately.

One of these, from Dike 184, at Andrew's Point, Cape Ann, has already been described[1] as composed essentially of feldspar and glaucophane-riebeckite, with very little quartz. At that time, however, only sections from the border of the dike were available. Since then I have studied sections from the center as well with interesting results. The borders of the four-foot dike are very fine-grained and compact and of blue-gray color. At the center the rock becomes coarser, but is still fine-grained, and is composed of small black specks in a light gray groundmass.

Examining the sections under the microscope, it is seen that in the borders the hornblende is nearly constantly glaucophane, yet, as we approach the center, there are found streaks in which a bright grass-green aegirite partly replaces it. At the center the grain is larger, and the feldspars tend to become automor-

[1] H. S. WASHINGTON, Am. Jour. Sci. (4), VI, p. 176, 1898.

phic, the development being thick tabular, and a radiated arrangement quite common. The dark blue hornblende is present here in larger grains, but less abundant, while the green pleochroic aegirite, showing the usual characters is fully as abundant as it, and in places more so. The aegirite does not occur in needles, but mostly in stout, irregular anhedra, and only occasionally in rough prisms. Small crystals of a yellow-brown, highly pleochroic biotite are also seen. There are also numerous small, slender needles of a bright yellow pleochroic mineral, often arranged in stellate groups. Their pleochroism varies with the depth of their color, the deepest showing a reddish-yellow parallel to the length, and a lighter greenish-yellow perpendicular to this, while the paler ones show scarcely any pleochroism. These are the same which were thought to be either apatite or rosenbuschite in the former description, but here their larger size and more intense coloration permits of a better examination, and it seems that they are to be referred to astrophyllite.

A sölvsbergite of a somewhat different type is that forming Shaler's Dike 182, near Pigeon Cove, on Cape Ann. The dike itself is three to four feet wide, with strike N. 73° W. At one place a tongue of granite about ten feet in length protrudes into the dike. In this tongue, as well as immediately outside for a distance of twenty feet along the dike and a foot from it, the granite has been squeezed, and a gneissoid structure developed, the foliations on the outside bending around towards the tongue and being parallel to its length within it. Examined in thin section, the quartz and feldspars of this gneissoid granite are seen to have been squeezed, crushed, cracked, and frequently drawn out into lenticular shapes, exactly as in many gneisses. It is remarkable that such a squeezing should have taken place over such an extremely limited area, the granite outside of the gneissoid portion and on the other side of the dike being absolutely normal in character.

But to return to the dike. This is dark gray and compact, with a few small phenocrysts of aegirite and feldspar. In thin section, it is seen to be composed of a pale greenish hornblende,

pleochroic in light tints of blue-green and yellow-green, and with an extinction angle of 15°, partly in large, stout phenocrysts, but mostly as small, irregular grains, with small, stout flakes of a peculiar light brownish-gray biotite, embedded in microperthitic feldspar, generally in anhedra, but occasionally showing roughly tabular forms. Neither aegirite nor the normal blue hornblende is to be seen, nor was any quartz found.

A very pretty sölvsbergite forms Dike 55, which cuts the granite at the pier of the Hawthorne Inn, East Gloucester. The rock is aphanitic and chiefly a dull gray, but is mottled with streaks of white or greenish-gray, which run parallel to the walls. Under the microscope the only phenocrysts visible are a few sharply automorphic ones of alkali-feldspar, which are composed of orthoclase and albite, not arranged microperthitically, but forming aggregates of small granular anhedra. This structure seems to be due to secondary processes, as the rock is not quite fresh, and the sharp crystal outlines of the aggregates show that they were originally well-defined crystals. The groundmass is composed of a finely granular alkali-feldspar, possibly with a little quartz, thickly sprinkled with small blue or green needles. Most of these are of bluish-gray glaucophane, and are of two sizes. The smallest, usually less than .01 mm in length, tend to accumulate in rounded patches or streaks, surrounded by clearer feldspar carrying sparsely scattered, larger needles. Other streaks occur in the sections, corresponding to the pale streaks seen in the hand specimen, which are of feldspar carrying pale green aegirite needles and grains, with little, if any, glaucophane. In one place the orthoclase and albite are intergrown radially, forming sphaerocrystals which give a black cross between crossed nicols.

Another sölvsbergite, the specimen of which I owe to the kindness of Mr. Sears, occurs as a dike at West Cove, Coney Island, in Salem Harbor. This has been described by Rosenbusch, who calls it a bostonite-porphyry.[1] To a certain extent,

[1] ROSENBUSCH, Mikr. Phys., Vol. II, p. 425; also Elemente der Gesteinslehre, 1898, p. 198, where it is called "bostonitic alkali-syenite-porphyry."

my specimen agrees with his descriptions, especially as to the megascopical appearance, the feldspars and the flow structure. But there is a marked discrepancy in the colored components, and it is evident that here also the dike varies in character in different parts, assuming that the two specimens came from the same dike. From analogy with the Andrew's Point dike, it would seem that Rosenbusch's specimen came from the border, while mine came from near the center.

The rock is rather dark gray, fine-grained, and, in my specimen, with little suggestion of silky luster. The tabular alkali-feldspar phenocrysts are identical with those described by Rosenbusch. This author speaks of a blue glaucophane-like hornblende as the only colored component. In my specimen this occurs very sparingly, its place being taken by a highly pleochroic, peculiar olive-green hornblende, bright green aegirite grains, and flakes of a greenish-brown, intensely pleochroic biotite. Generally these are scattered uniformly through the section, but in places one or the other predominates. A few phenocrysts of colorless diopside are seen, surrounded by a narrow border of aegirite. A number of fair-sized titanite grains and a few apatite needles are present, but quartz is wanting. Flow-structure is very pronounced, and is well brought out between crossed nicols, on account of the highly tabular development of the groundmass feldspars.

The last of the sölvsbergites to be described was found as blocks in a wall along the back road southwest of Bass Rocks. It is very dense and compact and of a deep bluish-gray color. Under the microscope no phenocrysts are visible, and practically the only colored component is a deep blue glaucophane, which occurs in abundant needles or stout prisms. There are also present, in extremely small amount, small grains of colorless diopside, but no aegirite, biotite, or green hornblende. The rock is chiefly remarkable for its colorless base, which is composed of alkali-feldspar, with considerable quartz — enough to justify the name quartz-sölvsbergite. These are partly irregularly granular, but also form small patches with micro-

graphic texture, which are highly characteristic and very abundant.

The provenance of these blocks is not known, but they probably come from a dike in the immediate vicinity. Search revealed an outcrop of a dense, very pale gray dike, with only a slight tinge of blue, near a small pond across the road. This is evidently a bleached-out sölvsbergite, since the microscope reveals the fact that the small, originally blue, hornblendes are nearly all entirely decomposed to an opaque black substance, with little change of form, and small crystals of diopside are also possibly derived from them. This rock also shows the peculiar and striking micrographic patches, and it is therefore highly probable that the wall blocks were obtained from freshly blasted portions of this dike.

Only two analyses have been made by me of these rocks, which are given below. For comparison there are quoted an analysis of the Coney Island dike recently published by Rosenbusch, as well as two analyses of Norwegian sölvsbergites.

	I	II	III	IV	V
SiO_2	64.28	61.05	60.60	62.70	64.92
TiO_2	0.50	0.34	0.71	0.92	....
Al_2O_3	15.97	18.81	18.28	16.40	16.30
Fe_2O_3	2.91	2.02	2.85	3.34	3.62
FeO	3.18	3.06	2.67	2.35	0.84
MnO	trace	trace	....	trace	0.40
MgO	0.03	0.42	0.52	0.79	0.22
CaO	0.85	1.30	0.99	0.95	1.20
BaO	none	none	....	....	....
Na_2O	7.28	6.56	6.66	7.13	6.62
K_2O	5.07	6.02	5.73	5.25	4.98
H_2O (Ignit.)	0.20	0.78	0.69	0.70	0.50
P_2O_5	0.08	....	0.15	....	....
	100.33	100.04	99.85	100.53	99.60

I. Sölvsbergite. Dike 184, Andrew's Point, Cape Ann. H. S. Washington anal. Amer. Jour. Sci., (4) VI, p. 178, 1898.

II. Sölvsbergite. Dike. Coney Island, Salem Harbor. H. S. Washington anal.

III. Sölvsbergite ("Bostonitic Alkali-syenite-Porphyry"). Coney Island. M. Dittrich anal. Rosenbusch, Elem. d. Gest. lehre., 1898, p. 199, No. 3.

IV. Katoforite-Sölvsbergite. Lougenthal, Norway. L. Schmelck anal. Brögger, *op. cit.*, I, p. 80.

V. Aegirite-Sölvsbergite. Sölvsberget, Gran, Norway. L. Schmelck anal. Brögger, *op. cit.*, p. 78.

The Andrew's Point sölvsbergite is rather acid and approaches closely the katoforite-sölvsbergite from the Lougenthal. It resembles the Coney Island dike in its main features, especially in the high alkalies and the relations of the iron oxides. The two analyses of the Coney Island dike resemble each other very satisfactorily, and show that it is rather more basic, approaching the Kjöse-Aklungen dike, which, however contains a little nepheline. It is evident from these analyses and the descriptions given that the Coney Island rock is really a sölvsbergite and not a bostonite-porphyry, for which indeed, as Rosenbusch himself remarks, it carries an abnormally large amount of colored minerals.

Tinguaite.— The most basic members of the series we are now discussing, the tinguaites, which are not abundant in Norway, occur very sparingly in Essex county, only three dikes of this rock having come to my notice.

One of them, an analcite-tinguaite, from Pickard's Point near Manchester, has been already described.[1] It is aphanitic and olive-green, with only rare phenocrysts of feldspar in a groundmass of aegirite needles, alkali-feldspar, nepheline and analcite. The perfect freshness of the rock, as well as theoretical considerations, lead to the conclusion that the analcite is primary.

The second tinguaite occurrence is that recently described by Dr. A. S. Eakle[2] as a biotite-tinguaite from Gale's Point near Manchester. It is composed of alkali-feldspar, nepheline, kaolin and secondary quartz, aegirite, and a little biotite and magnetite. As Dr. Eakle points out it approaches the nepheline-bearing sölvsbergite from Kjöse-Aklungen already mentioned, and might be classed with the sölvsbergites.

The third occurrence of tinguaite is a dike two hundred yards east of Squam Light, discovered by Mr. Sears, to whom I am indebted for a specimen, The rock is dark green and very dense. This is also a biotite-tinguaite and very fresh. No phenocrysts are visible. Abundant small irregular grains and

[1] H. S. WASHINGTON, Am. Jour. Sci., (4), VI. p. 182, 1898.

[2] A. S. EAKLE, Am. Jour. Sci., (4), VI, p. 489, 1898.

prismatic crystals of aegirite with fewer small flakes of brown biotite, are strewn in a colorless base composed of small tabular alkali-feldspars with interstitial nepheline. Colorless needles of what is probably diopside are also present, but no magnetite was seen. The rock shows a well marked flow structure.

Of these rocks we have two analyses, both already published, one of the Pickard's Point analcite-tinguaite, the other of the biotite-tinguaite. With them are given for comparison analyses of the border and center of the Hedrum tinguaite dike and the Kjöse-Aklungen sölvsbergite.

	I	II	III	IV	V	VI
SiO_2 -	56.75	60.05	56.58	55.65	58.90	54.22
TiO_2 - -	0.30	0.11	....	....	0.40	0.38
Al_2O_3 -	20.69	19.97	19.89	20.06	17.70	20.20
Fe_2O_3 - -	3.52	4.32	3.18	3.45	3.94	2.35
FeO - -	0.59	1.04	0.56	1.25	2.37	1.02
MnO - -	trace	0.79	0.47	....	0.55	0.19
MgO -	0.11	0.23	0.13	0.78	0.54	0.29
CaO - -	0.37	0.91	1.10	1.45	1.05	0.70
BaO -	none	....	....	....	....	trace
Na_2O - -	11.45	7.69	10.72	8.99	7.39	9.44
K_2O -	2.90	3.24	5.43	6.07	5.59	4.85
H_2O (110°)	0.04	0.15	....	....	....	0.42
H_2O (ignit) -	3.18	1.26	1.77	1.51	1.90	5.57
Cl - -	0.28	0.28	....	....	....	P_2O_5 0.11
	99.92	100.04	99.83	99.21	100.33	99.74

I. Analcite-Tinguaite, Pickard's Point. H. S. Washington anal. Trace of SO_3. Am. Jour. Sci. (4), VI, p. 185, 1898.

II. Biotite-Tinguaite, Gales Point. A. S. Eakle anal. Am. Jour. Sci. (4), VI, p. 491, 1898.

III. Tinguaite (dike border). Hedrum, Norway. G. Pajkull anal. Brögger, *op. cit.*, I, p. 113.

IV. Tinguaite (dike center). Hedrum. V. Schmelck anal. Brögger, *op. cit.*, p. 191.

V. Nepheline-Sölvsbergite. Kjöse Aklungen, Norway. V. Schmelck anal. Trace of P_2O_5. Brögger, *op. cit.*, p. 102.

VI. "Phonolite" (Tinguaite?) H. N. Stokes anal. Southboro, Mass. Bull. 148. U. S. G. S., p. 77.

In I the only points which need be mentioned here are the rather low silica, high soda, and, for so fresh a rock, the high

content of water. It very closely resembles the Hedrum border rock, except in water and potash. The biotite-tinguaite is more acid, and closely corresponds in general features to the analysis of the Coney Island sölvsbergite. The characteristic distinction, however, is found in the relative amounts of the iron oxides and in the alkalies. In these respects the two tinguaite analyses resemble each other, and these two features, taken together, serve to differentiate their analyses from those of the more basic sölvsbergites. This whole series presents several points of interest, as regards the relations of the various members to each other, and their relative composition, but discussion of these features will be deferred to a later page. In connection with these rocks I may call attention to a so-called phonolite from Southboro, Mass., whose analysis is given in VI. Although not described an examination of sections of specimens kindly sent me by Professor B. K. Emerson proves that they are typical aegirite-tinguaites, one specimen showing very sharp nepheline crystals.

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(To be Continued)